Space Technology Demonstrations Using Low Cost, Short-Schedule Airborne and Range Facilities at the Dryden Flight Research Center

NSRC

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Brief Overview

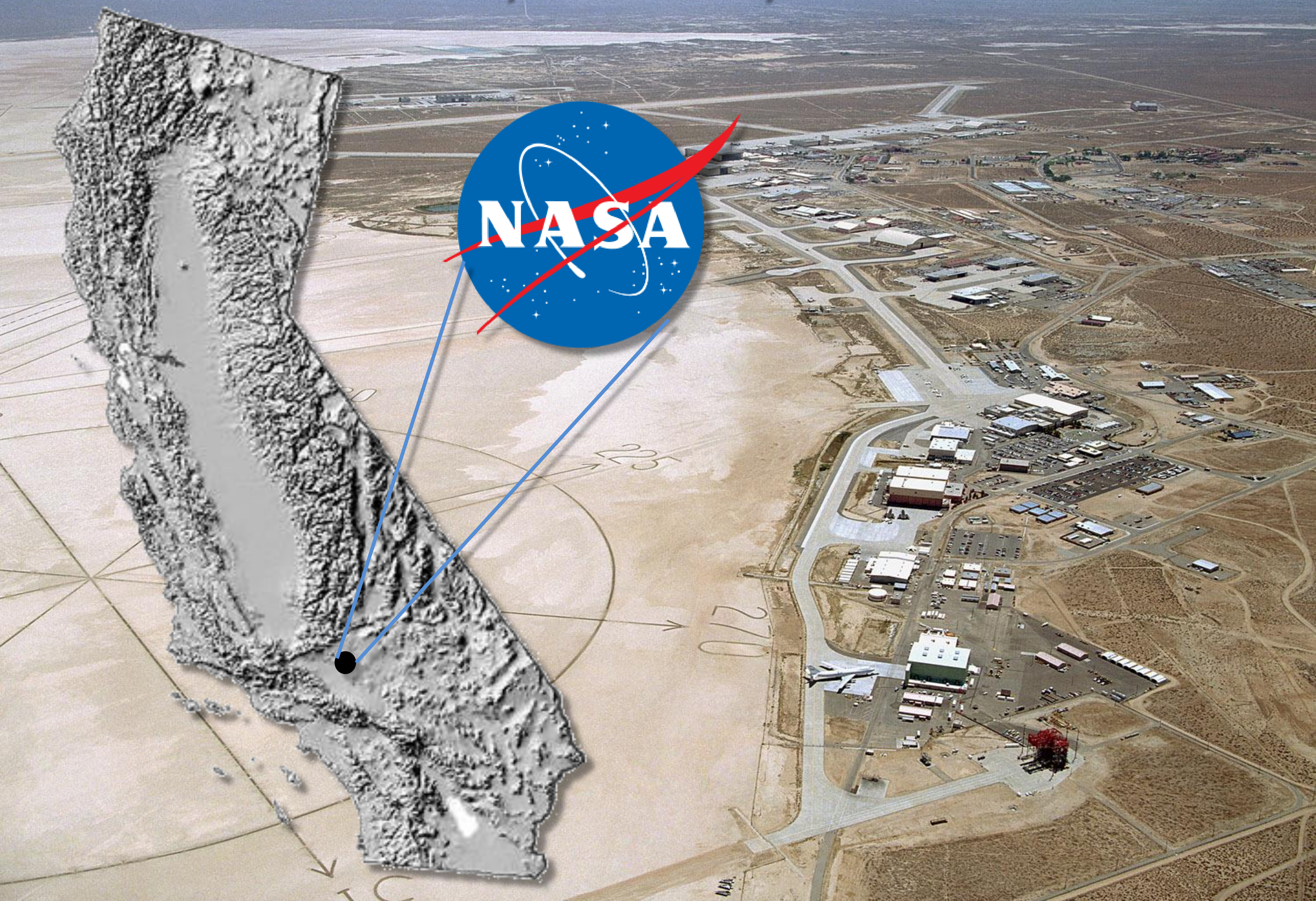
We need to expedite advanced space technologies on new space systems

These technologies need to be demonstrated in a relevant environment before being installed in new space systems.

This presentation introduces several low cost, short schedule space technology demonstrations using airborne and range facilities available at the Dryden Flight Research Center.

Just because it doesn't look like a rocket doesn't mean that you can't reduce rocket technology risk !

Location, Location, Location!



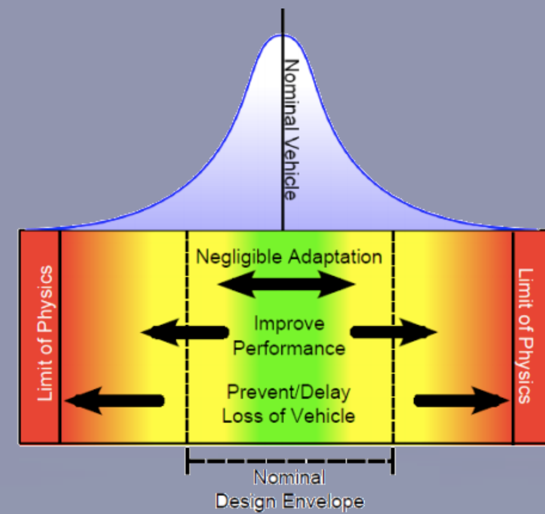
An Alliance with EAFB allows access to . . .

- Restricted Airspace
- Rogers Dry Lake
- The Precision Impact Range
- Tracking and Communication

Example: Flight Test of Space Launch System (SLS) Technology

Launch Vehicle
Flight Control Design Challenges

- Large, highly flexible vehicle structure
- Propellant tanks with lightly damped lateral sloshing modes
- Uncertain dynamic characteristics of payload envelope (elastic, slosh)
- Widely varying operating conditions
- Complex multi-engine Thrust Vectoring Control
- Robustness and Redundancy requirements for human rating



Solution: adaptive control

Adaptive control provides additional robustness by using sensed data to adjust the gain on-line; senses off-nominal upper and lower limits in real time.

The solution can be tested *in flight* quickly and easily . . .

SLS Adaptive Control Experiment on F-18

F-18 Experiment Configuration

- Replicate SLS dynamics using the on-board F-18 research computers
- Use a research autopilot to fly a pitch-over trajectory
- Turn adaptive controls on/off and examine effect

Peak altitude
28 kft

Initial altitude
15 kft

1.Accelerate to 0.75M

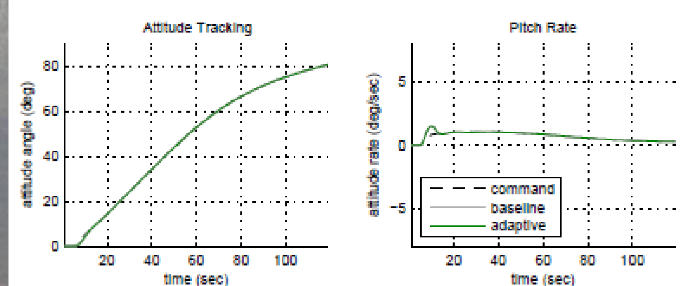
2.Zoom to 70º pitch angle and decelerate to RFCS envelope (< 250 kts)

3.Arm and engage research controller

4.Begin to track a constant +0.2g trajectory for 30 seconds (-1 deg/sec pitch over)

5.Disengage and recover at -30º pitch angle

Representative Pitch Axis Flight Trajectory*



**From Orr and VanZwieten, AIAA 2012-4549*

The F-15 Flight Testbed—Advancing Technology through Captive-Carried Flight

- Active Propulsion experiments
- Aero experiments
- Fiber Optics experiments
- Supersonic envelope
- Fully instrumented
- Low cost and quick schedule

Shuttle Thermal Protection System

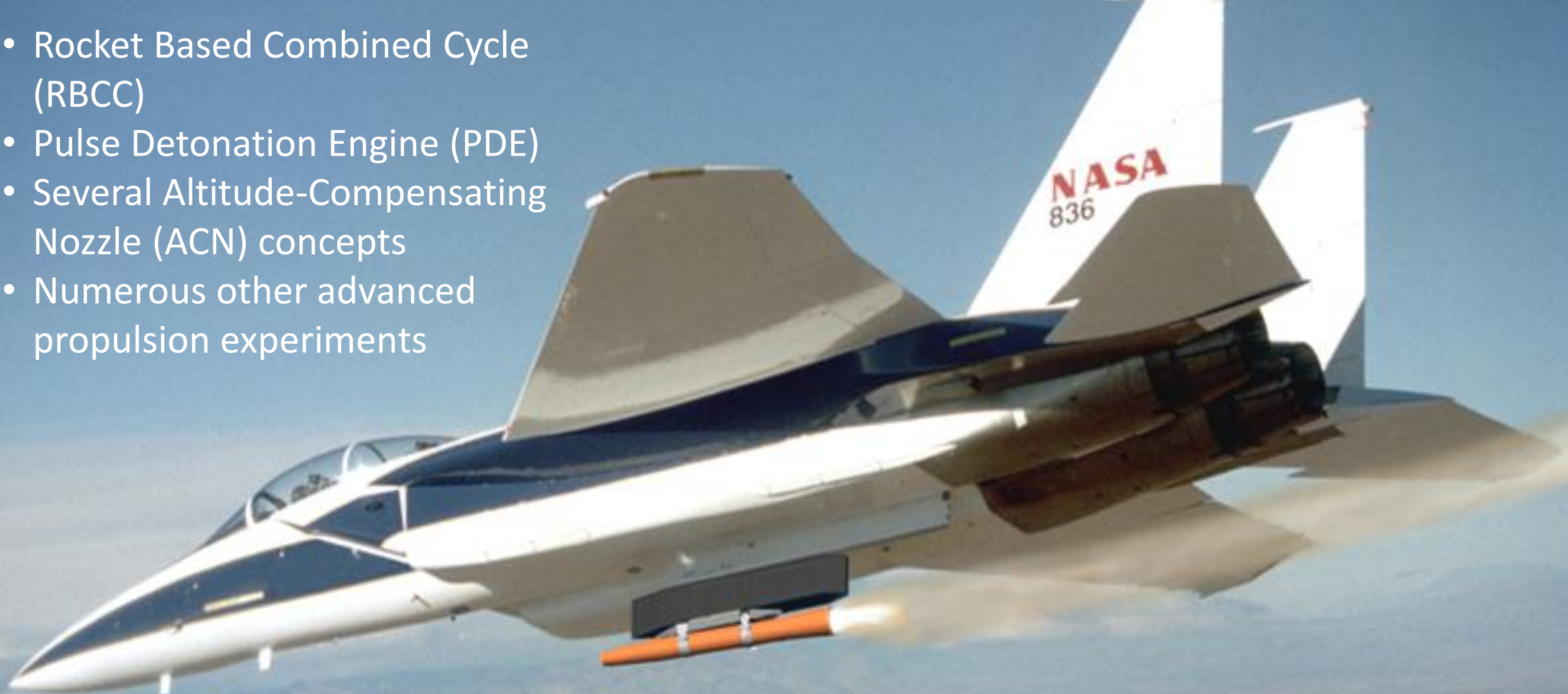
Supersonic Boundary layer

Advanced Inlet design

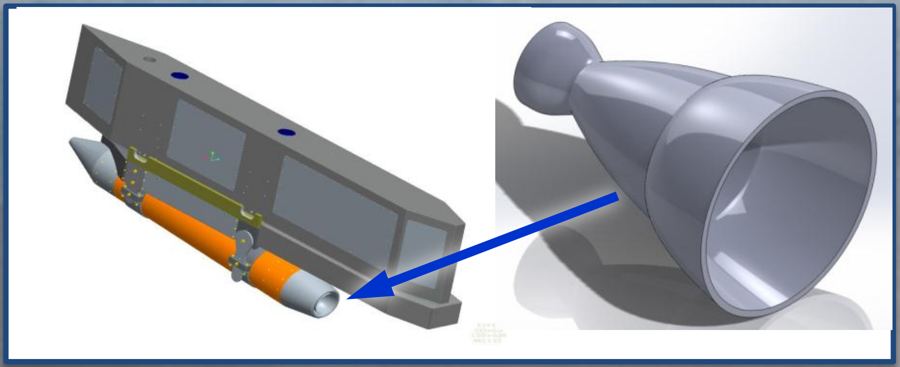
The F-15 Propulsion Flight Test Fixture (PFTF)

Advanced Rocket Propulsion Experiments

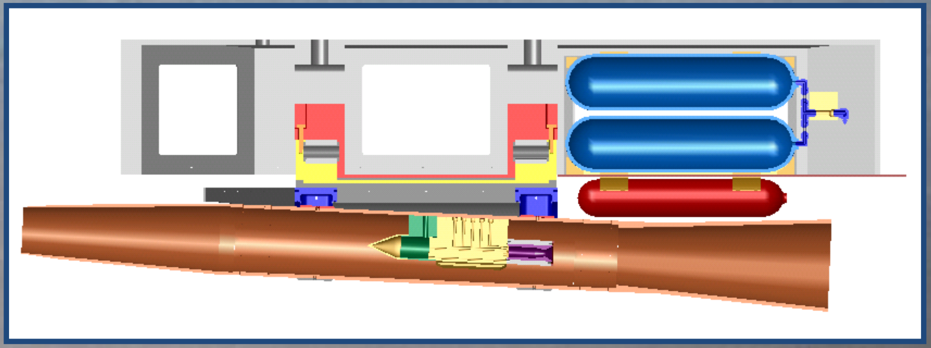
- Rocket Based Combined Cycle (RBCC)
- Pulse Detonation Engine (PDE)
- Several Altitude-Compensating Nozzle (ACN) concepts
- Numerous other advanced propulsion experiments



ACN: Dual-Bell Rocket Nozzle Conceptual Design



RBCC Conceptual Design



Rockets

- One Test
- Don’t get test article back
- $Millions
- Limited schedule
- Long lead time

Test Beds

- Almost Unlimited tests
- Get test article back for reuse
- $Thousands
- Flexible schedule
- Short lead time

Not only high-speed test beds, but test beds that can reach high altitudes for long periods of time

- High altitude sensing
- Observations above water vapor
- Modern Transponders/Communication

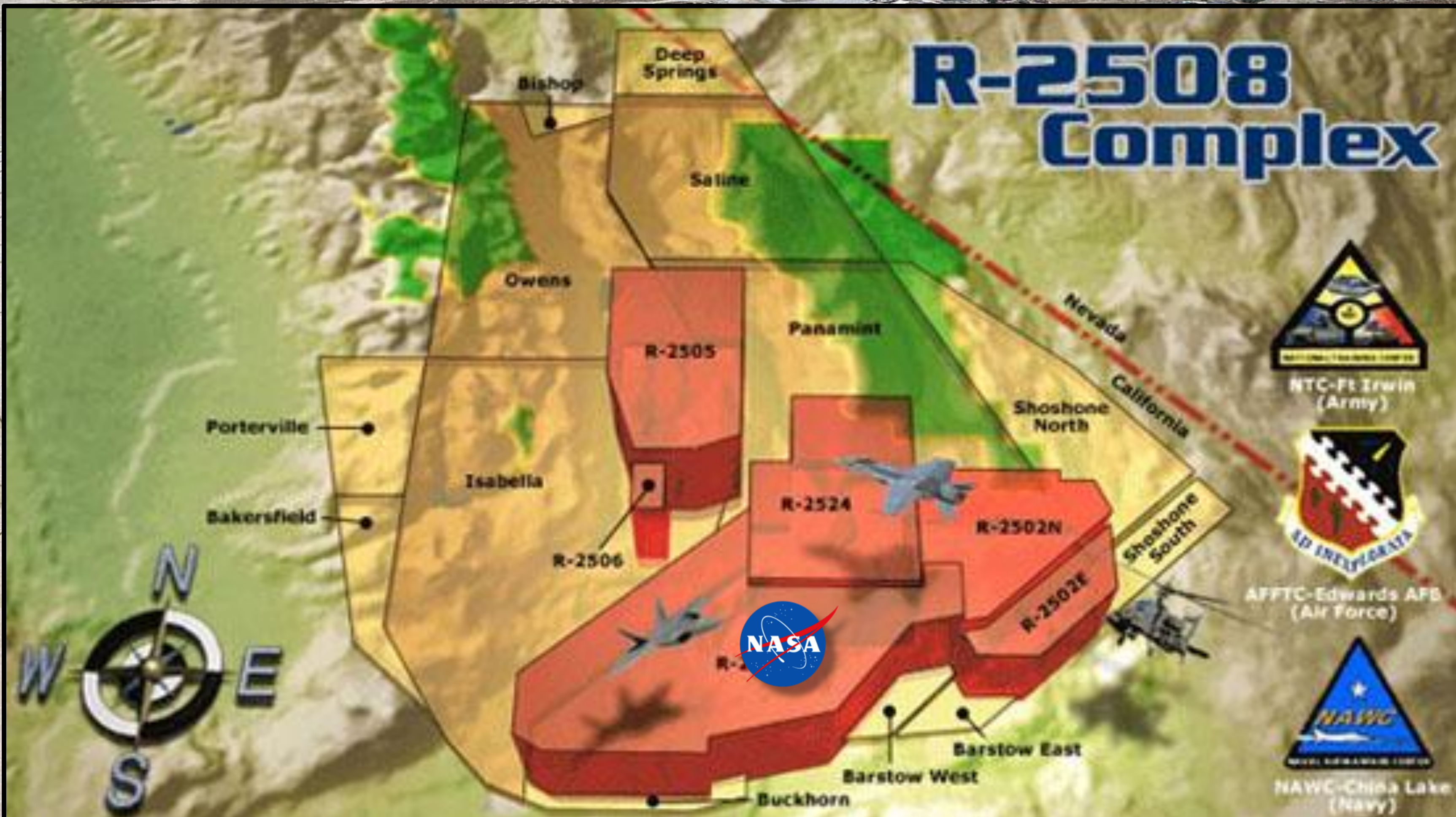
— ER-2
65,000 ft, 6 – 10 hrs, 6,000 mile range

— Global Hawk
65,000 ft, 31hrs, 10,000 mile range

Ikhana (MQ-9 Reaper) —
40,000 ft, 24 hrs, 10,000 mile range

http://www1.nasa.gov/centers/dryden/aircraft/index.html

Access to Restricted Airspace . . .



Short Schedule, High Value Testing and Demonstrations

Power-Beaming Centennial Challenge

SNC Dream Chaser Approach and Landing Tests

ALHAT Field Demonstration

(Autonomous Landing and Hazard Avoidance Technology)

Autonomous Landing and Hazard Avoidance Technology

Mars Science Lander Curiosity Radar testing

F-18 Radar Calibration of the on chute portion of the MSL descent

Helicopter testing mimicking the rocket powered MSL descent, looking for radar clearance around the rover

Mars Science Laboratory Landing Radar Testing

Questions ?

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Dryden Aircraft Descriptions and POC's

http://www1.nasa.gov/centers/dryden/aircraft/index.html